Xeric and Lower Montane Forest

Photo courtesy of WGFD

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Habitat Description

Xeric and lower montane forests exist in a variety of areas in the western United States and Wyoming ranging from lower elevations to high elevations (Arno 1980, Bock et al. 1993, Green and Conner 1989, Idaho Partners In Flight 2000, Knight 1994, NatureServe 2009). NatureServe (2009) lists eight ecological systems in Wyoming (Table 22). Within the three ponderosa pine systems they list over 50 associations, and within the five limber pine/juniper systems they list over 40 associations in the western United States. Historically, before about 1890, frequent fires often confined these conifer woodlands to rocky sites or the leeward sides of slopes. Typically, this fire pattern created open savannahs and patchy, park-like woodlands. Present conditions have changed the appearance and distribution of these ecosystems across the landscape. Mature forest landscapes are more fragmented and denser with younger trees dominating stands. At many sites, tree densities and fuel loads would support high intensity crown fires rather than the low intensity understory fires typically associated with these sites. In some areas stands are expanding into adjacent grassland and shrublands. Common uses of these forests include wildlife habitat, livestock grazing, commercial timber harvesting and firewood gathering, recreation, residential development, and mineral development. The lower elevation and openness of this habitat type often leads to more intensive human activity.

Juniper

Junipers are conifers with leaves of overlapping scales and seed-bearing cones that resemble small berries. Juniper sometimes forms pure stands, but is often mixed with other gymnosperms (Elias 1980). It commonly grows on bluffs, ridges, cliffs, and dry, rocky hillsides, and it does best on slightly alkaline/calcium-based soils (Elias, 1980). Only 2.2% of the land area in Wyoming supports juniper woodlands. Juniper can be found from 4,000 to 10,000 feet in elevation, but it generally occurs below 6,000 feet (Nicholoff 2003). In these areas, annual precipitation averages 8 to 20 inches (West et al. 1975), and typically comes in the form of snow, spring rain, and infrequent summer thunderstorms.

Rocky Mountain and Utah juniper are widespread, ranging from British Columbia to Arizona and New Mexico, and from Nevada and Washington east to the Dakotas and Nebraska. They are the most common juniper species in Wyoming. Utah juniper is found along escarpments in western Wyoming and in arid basins throughout the state. Rocky Mountain juniper is found in eastern Wyoming along ravines that receive greater summer precipitation and is often found in association with ponderosa pine, mountain-mahogany, or limber pine.

Today, in Wyoming, tree densities in juniper communities vary from open savannahs to closed canopies. Prior to European settlement, juniper woodlands ranged from savannah-like conditions to more closed canopy stands on rocky ridges and rocky low sagebrush flats. Fire return intervals and severities were mixed in juniper communities and were very site specific. Low intensity fires may have occurred every few decades, while high intensity crown fires occurred less frequently, often in terms of centuries (Baker and Shinneman 2004). This mix of fire severity created a mosaic of different tree densities and associated grass and shrub species.

Since 1860, the distribution of juniper woodlands has increased 125–625% across the West (Miller et al. 2008), although juniper expansion has not been as dramatic in most areas of Wyoming as it has been in other areas of the West (Nicholoff 2003). Juniper expansion has most frequently occurred northward, as well as downward in elevation into grasslands and shrublands with deeper soils, more fine fuels, and previously higher fire frequencies (Gillihan 2006). The cause of this expansion is debated. Some researchers contend that expansion is part of a natural cycle in response to changes in climate, citing documented evidence that juniper has been on this landscape since 10,000 years before present (BP) (Jackson, et al. 2005). Since this period, the range of juniper has probably varied in response to the documented climatic variations such as the Medieval Climate Anomaly and the Little Ice Age. In addition to climate fluctuations, it is widely agreed that in some areas the recent expansion of juniper has been aided by a combination of fire suppression and overgrazing.

Unlike in the southwestern United States, mature piñon (or pinyon) pine is uncommon in juniper woodlands in Wyoming. Exceptions can be found in southwestern Wyoming near Flaming Gorge Reservoir and in the foothills of the Uinta Mountains. Shrub species associated with juniper woodlands include big sagebrush, black sagebrush, true and curl-leaf mountain-mahogany, rabbitbrush, antelope bitterbrush, yucca, and skunkbush sumac (Knight 1994).

Juniper expansion can alter the local plant communities by reducing the abundance of grasses, forbs, and shrubs through competition for water, light, and nutrients, as well as by producing plant-growth inhibiting chemicals. Dense stands of juniper can also change the hydrology of a site by increasing erosion. The reduction of the herbaceous understory increases water runoff and decreases water infiltration. This reduction in understory plants creates an extended period of self-perpetuating conditions favorable for juniper expansion by reducing the amount of fuel available for fire. Thinning juniper and increasing shrubs and herbaceous cover may create a more historic fire return interval by improving fuel availability.

Juniper wood is resistant to decay, is durable and clean-burning, and it is often harvested for fence posts, poles, firewood, and furniture making. In Wyoming, approximately 572,000 acres (231,000 ha) of juniper habitat are in public ownership; the remaining 282,000 acres (114,000 ha) are privately owned (Thompson et al. 2005).

Limber Pine

Limber pine comprises about 4% of Wyoming forested lands (Wyoming State Forestry Division 2009). Limber pine is a generalist and pioneer species, and it is cold- and drought-tolerant, allowing it to grow under a wide variety of environmental and physiological circumstances (Schoettle 2004). It grows across the widest elevational range of any conifer in the Rocky Mountains, ranging from approximately 5,250 feet to almost 11,000 feet (Schoettle and Rochelle 2000). At low elevations it often occurs with ponderosa pine, juniper, and Douglas fir, and at treeline it is frequently located in association with whitebark pine. Limber pine has been documented as having moved both upslope and downslope throughout the Holocene (approximately 11,500 years BP to present day), driven by factors such as drought, changing climate, and management techniques (Means 2010).

In some circumstances, changing fire regimes combined with low competitiveness with other species, poor regeneration due to blister rust, and spreading infestations of mountain pine beetle are altering distribution and lowering survival for limber pine. Where many of these woodlands serve as climax communities, limber pine can reach ages of up to 1,500 to 2,000 years (Tomback 2009). It often has irregular or multi-stem growth formation on harsh exposed sites and may even have Krummholz formation at higher elevations, rarely reaching over 50 feet in height. Typically limber pine has been restricted to rocky soils and ridges because the seedlings do not compete well with other species (Knight 1994). Choke cherry, ground juniper, king spike fescue, mountain big sagebrush, Oregon-grape, and western snowberry are commonly found with limber pine (Knight 1994). Although limber pine has received little attention, it fills a similar ecological role to whitebark and piñon pine. As a pioneer species, it regenerates well after fire or canopy-opening disturbances. It acts as a nurse tree, facilitating the establishment of later successional species at both low and high elevations (Baumeister and Callaway 2006, Rebertus et al. 1991, and Tomback 2009).

Ponderosa Pine

Ponderosa pine can grow to over 130 feet tall and occurs on a wide variety of soils, usually in open areas because this species is intolerant of shade. Trees can grow in pure stands, especially at lower elevations where they are subject to frequent forest fires. Ponderosa pine and limber pine are commonly found in Wyoming foothills and on escarpments in warmer areas with higher summer precipitation. Areas with notable concentrations of ponderosa pine include the Black Hills, at lower elevations in the Bighorn Mountains, on the east slope of the Laramie Mountain range, and in a few localities around the Medicine Bow, Split Rock, and Seminoe Mountains (Knight 1994). Associated tree species in the Black Hills include the southernmost outliers of white spruce and paper birch in the U.S. and in the more northern parts of the Black Hills there is a significant component of bur oak and green ash. Aspen is also present but typically not in pure stands. Other tree species associated with ponderosa pine in other parts of the state include Douglas fir, limber pine, lodgepole pine and Rocky Mountain juniper. Other woody and herbaceous plant species frequently found with ponderosa pine include skunkbush sumac, sideoats grama, and little bluestem (Knight 1994).

Ponderosa pine is a fire adapted tree. Adaptations to survive surface fires include open crowns; self-pruning branches; thick, insulative, relatively inflammable bark; thick bud scales; tight needle bunches that enclose and protect meristems, then open into a loose arrangement that does not favor combustion; high foliar moisture; and a deep rooting habit (Howard 2003). Where fires are common, ponderosa pine often exists in savannah-like landscapes. Mean Fire Historic Interval (MFI) varies between ponderosa pine sites. Prior to the 1900s, ponderosa pine was perpetuated by surface fires that recurred every 5 to 30 years. (Howard 2003). Unlike in the southwestern U.S., ponderosa pine in Wyoming has a historical record of a mixed severity fire regime with crown fire being a component (Hunter et al. 2007) as well as low severity surface fires.

Pine leaves can be toxic to cattle, and trees reduce the rate of herbaceous forage production in the understory (Knight 1994).

Ponderosa pine is an important tree species for the forest industry in Wyoming. Sixty-six percent of the saw log harvest was composed of ponderosa pine in 2000 (Wyoming State Forestry Division 2009). Equally significantly, 73% of those materials came from privately owned forests (Wyoming Division of Forestry 2009). In particular, private lands in the northeast corner of the State are producing 78% of the harvest volume (The Conservation Fund 2009).

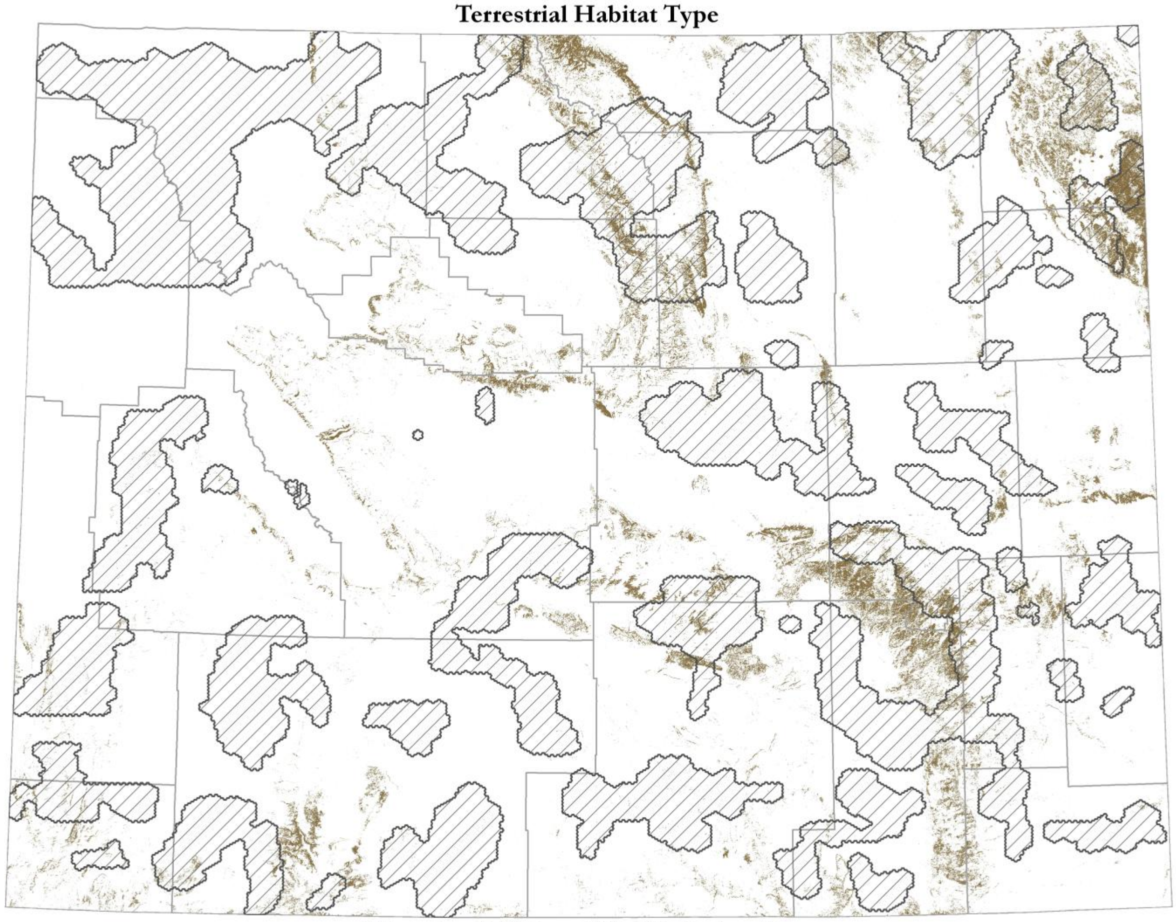

FIGURE 15. Wyoming Xeric and Lower Montane Forests and SWAP SGCN Priority Areas (cross-hatched areas)

TABLE 22. Wyoming Xeric and Lower Montane Forests NatureServe Ecological Systems[1]

1. Colorado Plateau Pinyon-Juniper Woodland
2. Northern Rocky Mountain Foothill Conifer Wooded Steppe
3. Northern Rocky Mountain Ponderosa Pine Woodland and Savanna
4. Northwestern Great Plains-Black Hills Ponderosa Pine Woodland and Savanna
5. Rocky Mountain Foothill Limber Pine-Juniper Woodland
6. Rocky Mountain Subalpine-Montane Limber-Bristlecone Pine Woodland
7. Southern Rocky Mountain Ponderosa Pine Woodland
8. Northern Rocky Mountain Subalpine Woodland and Parkland

[1] Descriptions of NatureServe Ecological Systems which make up this habitat type can be found at: NatureServe Explorer: an online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, VA. http://www.natureserve.org/explorer.

TABLE 23. Wyoming Xeric and Lower Montane Forests Species of Greatest Conservation Need

Birds
Ash-throated Flycatcher
Bushtit
Juniper Titmouse
Lewis's Woodpecker
Merlin
Pygmy Nuthatch
Western Scrub-Jay

Mammals
Big Brown Bat
Canyon Mouse
Cliff Chipmunk
Fringed Myotis
Long-eared Myotis
Long-legged Myotis
Little Brown Myotis
Northern Myotis
Pallid Bat
Piñon Mouse
Silky Pocket Mouse
Spotted Bat
Townsend's Big-eared Bat
Western Small-footed Myotis
Yellow-pine Chipmunk

Reptiles
Black Hills Red-bellied Snake
Northern Tree Lizard
Pale Milksnake
Smooth Greensnake

Xeric and Lower Montane Forests Wildlife

Juniper woodlands often have a higher abundance and diversity of birds than other habitats including big sagebrush, ponderosa pine, and lodgepole pine (Nicholoff 2003). In fact, piñon-juniper woodlands support one of the highest proportions of obligates or semi-obligate bird species (Paulin et al. 1999). Over 100 species of birds have been documented in the juniper woodlands of southwestern Wyoming and approximately 40 species nest there routinely (Nicholoff 2003). Higher bird concentrations in juniper stands are related to their structural diversity which provides numerous sites for perching, singing, and nesting. Most of the juniper obligates favor mature trees (older than 100 years) along with a shrub understory for nesting and foraging. Older trees with dead or dying limbs provide nesting sites for cavity nesters. Species richness is highest in early and mid-succession juniper communities because these provide both food and cover from the junipers as well as from their associated shrubs and grasses. Wildlife food from junipers comes in the form of plentiful berries and diverse insects. Species richness of all wildlife declines once juniper canopies close because there is less variety and quantity of food.

Many species of wildlife also use junipers for thermal cover. The shape of juniper trees is effective at blocking wind and trapping ground heat in winter and providing shade in the summer. Juniper is an important wintering habitat for mule deer and elk, and mule deer, in particular, also browse on juniper.

Sparse juniper and lower elevation limber pine habitats are often utilized by many reptile species. One notable example is the northern sagebrush lizard. Trees are often used as basking sites and thermal refugia. Yellow-bellied racers may also be found in this habitat at lower elevations.

Many ponderosa pine communities occur on south-facing slopes at elevations that lie between big game summer and wintering grounds. Due to these topographic features, ponderosa pine communities can provide quality early-green forage for mule deer. If fall moisture occurs, which is common, these slopes also provide green re-growth. Many of these communities support crucial winter range for mule deer and elk. Ponderosa pine forests also provide habitat for white-tailed deer, black bear, wild turkey, blue and ruff grouse, migratory songbirds, black-backed and American three-toed woodpeckers, olive-sided flycatcher, mountain bluebird, flying squirrels, and red squirrels, as well as various other rodent and squirrel species (Tomback 2009). Ponderosa pine is an important tree species for cavity-nesting birds such as mountain bluebirds, American kestrel, chickadees, wrens, and a variety of woodpeckers. In Wyoming, ponderosa pine savannas contain over 60% of Wyoming's known merlin nesting sites and a significant but not quantified portion of nesting Lewis's woodpeckers. Abert's squirrel is a ponderosa pine obligate species whose range just barely extends into Wyoming in the southern part of the Snowy Range. Clark's nutcracker is an important distributer of limber pine seeds across the landscape.

In southern Sweetwater County, rock outcrops in proximity to juniper habitats are particularly valuable to several SGCN mammals. The distribution of the cliff chipmunk, canyon mouse, and piñon mouse is restricted to this portion of the state. Important habitat components include high diversity of invertebrates, as well as vegetative seeds and berries. Also, the steep cliffs and canyons that are common in juniper woodlands provide many opportunities for rock and crevice-roosting bats. The structural diversity, shrub understory, and other vegetation in most juniper woodlands provide high insect diversity and important foraging habitat for several species of bats (Hester and Grenier 2005).

Xeric and Lower Montane Forests Habitat Threats

Fire suppression - High

Prior to European settlement, fire was a frequent occurrence in ponderosa, limber pine, and juniper forests and produced savanna-like landscapes. Fire suppression has resulted in range expansions, increased tree densities, buildup of dead downed material, and reduced understory plant species diversity in these woodlands. Increased densities in ponderosa pine stands have led to hotter crown fires occurring more frequently and over larger acreage when compared to historic fire patterns. In the Laramie Range, this has resulted in many ponderosa pine forests changing to grasslands during the last 10–15 years. The loss of old growth has resulted in few snags (see Wyoming Leading Wildlife Conservation Challenges – Disruption of Historic Disturbance Regimes).

Diseases and insects – High

Bark beetles (*Ips* spp), including mountain pine beetles (*Dendroctonus* ssp.; MPB), are serious pests to ponderosa pine, piñon, and limber pine with regular infestations occurring over centuries. There have been significant outbreaks of MPB in the Black Hills every 11–20 years. MPB tends to most seriously impact second-growth stands that have been undisturbed for many years. However, beetle epidemics combined with environmental conditions such as prolonged drought has resulted in increased pine mortality in many regions (Howard 2003). The spread of MPB has been aided by the general warming climate, by the persistent drought of the early 2000s, as well as by management practices which have excluded fire and reduced tree thinning and harvest.

White pine blister rust (WPBR), an exotic disease, is currently infecting all age classes of limber pine at all elevations (Means 2010). This disease, in conjunction with MPB, will likely reduce the future abundance of this species throughout its range in Wyoming. Greenhouse trials have shown limber pine has infection levels as high as 98–100 % and mortality rates of 75% (Hoff and McDonald 1993). The low resistance of limber pine to WPBR reduces the number of potentially resistant trees. When limber pine stands are lost due to WPBR infections, the limber pine becomes functionally extinct in the local area for hundreds of years until rust-resistant types emerge (Kendall 1997).

Dwarf mistletoe (*Arceuthobium* spp.) is a serious disease for limber pine (Koski et al. 2009) and ponderosa pine, with ponderosa pine infection rates up to 33% in some areas (Howard 2003). Dwarf mistletoe alters tree form, suppresses growth, and reduces volume and the overall wood quality of its host (Epp and Tardif 2004).

Invasive species – High to Moderate

Cheatgrass and other annual grasses such as Japanese brome are invading juniper, limber pine, and ponderosa pine forests. Invasions often originate from disturbed sites at lower elevations. These fire-adapted, nonnative species have the potential to increase the frequency of fire and reduce native grasses and forbs, which supply wildlife forage and support insect diversity (see Wyoming Leading Wildlife Conservation Challenges – Invasive Species).

Varied perceptions on the location and extent of removal and thinning treatments - Moderate

While their ranges have varied over the centuries, juniper and limber pine are believed to have expanded their range in Wyoming within historic times (Jackson et al. 2005). Because their establishment can result in decreased plant diversity and productivity, including reductions in forage for livestock and big game, removal and thinning programs are common. If not adequately considered, the value of this habitat type to obligate species can be unknowingly eliminated or reduced through the inclusion of prescribed treatment projects or the exclusion of fire suppression plans.

Drought and climate change - Moderate

In the Black Hills, some climate change modeling (Rehfeldt 2006) shows that climate has supported ponderosa pine transitioning into a new extramural climate that has not previously existed. If this continues to occur, spruce/paper birch habitat will become a decreasing component of the ecosystem, and ponderosa pine seedling establishment may become more sporadic. Observed lack of seedling and sapling establishment in at least one stand in the Bighorn Basin indicates stress from climatic change; however, some climate change models show a potential for ponderosa pine to expand in this and other areas (Joyce et al. 2001), which will be contingent upon temperature extremes, precipitation conditions, soil suitability, and a host of other factors.

Limber pine position on the lower treeline and foothills in semi-arid climate systems is predicted to be particularly vulnerable to climate change (Means 2010). Vegetation redistribution is likely to be most rapid and obvious at semi-arid ecotones (Allen and Breshears 1998). A multifactor combination of climate stress, dwarf mistletoe, WPBR, and bark beetles have created complex situations in limber pine forests, which has caused high population mortality in many areas (Schoettle 2004, Millar et al. 2007). A major drought event from 1985 to 1995 caused a widespread mortality wave, whereas a subsequent drought event from 1999 to 2004 did not affect as many populations, with healthy regeneration currently occurring in some areas (Miller et al. 2007). However, high potential still exists for an extensive, rapid drought-induced die-off at a sub-continental scale (Breshears et al. 2005, Coop and Schoettle 2009), particularly when trees have the physiological stress of fighting off pathogens, which can divert energy resources from other plant functions or make the plant more sensitive to environmental stresses (Schoettle 2004). Some research predicts that vegetation redistribution resulting from climate change is more likely to be driven by mass mortality as opposed to the establishment of new populations (Allen and Breshears 1998). Some preliminary research indicates that limber pine may be shifting its range downslope in response to changing climatic conditions (Means 2010). It is unknown how juniper species will be affected by climate change, but Rehfeldt (2006) predicted a significant decrease in Utah juniper in Wyoming by the year 2090. Finally, some studies have shown the infilling of sub-alpine coniferous forests at treeline and into alpine landscapes as a result of changing climate conditions (Joyce et al. 2007). (See Wyoming Leading Wildlife Conservation Challenges – Climate Change).

Habitat fragmentation – Moderate

Rural subdivision and development can reduce, degrade, and fragment foothill shrublands habitats (see Wyoming Leading Wildlife Conservation Challenges – Rural Subdivision and Development). Houses, outbuildings, and lawns directly replace native wildlife habitat. Soil disturbance from construction, year-round grazing of horses and other hobby livestock, and the use of nonnative plants as ornamentals can facilitate the establishment of invasive species (Maestas et al. 2002).

Wildlife commonly abandons or alters use of habitats with greater human and pet activity. Increased energy expenditures in avoiding people or greater use of lower quality habitat can decrease animal health and reproductive capacity. Greater road densities and traffic volume can increase wildlife–vehicle collisions. Predation on wildlife can intensify with greater numbers of domestic dogs and cats, as well as increases in generalist predatory species such as ravens and human-commensal species such as raccoons (U.S. Department of Agriculture 2007).

Fragmentation of land ownership can adversely affect natural resource management in ponderosa pine forest. As large blocks of private land are subdivided, habitat management may become more difficult. There is economy of scale in forest management, and management of small parcels can become economically unfeasible (Wyoming State Division of Forestry 2009). Easements for the use of roads across multiple landowners for habitat improvement projects can be expensive and difficult to obtain. Greater human safety and property loss concerns increase the need for fire suppression.

Off-road recreational vehicle use – Moderate

Vehicle use off established roads can enhance the spread of invasive species—especially spotted knapweed and cheatgrass—damage native vegetation, and destroy nests. Soil disturbance can increase erosion and impact water quality. Wildlife often avoids areas of increased noise and disturbance from outdoor recreational vehicles. These impacts can also lead to conflicts with hunting, wildlife viewing, and other forms of nature-based recreation.

Xeric and Lower Montane Forests Conservation Initiatives

The Wyoming Game and Fish Department, Bureau of Land Management (BLM), and The Nature Conservancy have been involved in thinning projects in the Lander, Platte County, Flaming Gorge, Baggs, Lovell, and Ten Sleep areas through both fire and mechanical means. The size and type of treatments typically vary depending upon the density of the stand, location in relation to other stands, existing understory vegetation, and threat of invasive species, primarily cheatgrass. Treating early and mid-successional stands is cheaper than treating dense, closed stands and often does not require post-treatment seeding. Removing juniper may lead to an invasion of weeds if the understory is missing or in poor condition.

A regional effort has brought together the US Forest Service, BLM, National Park Service, Colorado State University, and the Rocky Mountain Research Station to identify and grow WPBR-resistant limber pine through seed collection and breeding. It is expected that this project will initially take five or six years to develop seedlings for planting.

The Black Hills National Forest, the State of Wyoming, and BLM, along with private landowners, have undertaken aggressive forest health treatments to reduce ponderosa pine stand densities in order to lessen the impact of mountain pine beetle and crown fires. There have also been a number of efforts to reduce ponderosa pine tree densities on the west slope of the Big Horns, primarily on BLM lands. A National Science Foundation grant has been awarded to conduct workshops regarding climate change influence on ponderosa pine expansion in the Bighorn Basin. Other ponderosa pine management projects have been completed in the Ferris, Laramie, and other mountain ranges in the south central part of the state; however, most of this work has been localized.

Wyoming State Forestry Division (2010) has highlighted the need to maintain whitebark and limber pine stands in the Wyoming Statewide Forest Resource Strategy. The BLM in Wyoming has listed both whitebark and limber pine on their sensitive species list (Bureau of Land Management 2010a).

Recommended Xeric and Lower Montane Forests Conservation Actions

Identify juniper habitat within the state that should be managed for the long-term conservation of juniper obligate species.
Breeding populations for four avian and three mammalian SGCN (ash-throated flycatcher, bushtit, juniper titmouse, western scrub-jay, canyon mouse, cliff chipmunk, and piñon mouse) are limited to juniper habitats in a relatively small area in southwestern Wyoming. Resource managers should be informed of the location and value of these habitats so that they are not unknowingly included in prescribed treatment projects or automatically excluded from fire suppression plans without adequate consideration. In these areas, the Wyoming Bird Conservation Plan, Version 2.0. (Nicholoff 2003) should be consulted for appropriate management actions.

Outside of identified juniper obligate conservation areas, habitat management goals should be designed to maintain site ecological function with consideration to the historic climax plant community. The USGS Pinyon and Juniper Field Guide, Circular 1335 (Tausch et al. 2009) contains a good overview of site considerations and habitat treatment options.

Increase coordination among state and federal agencies, private landowners, and conservation groups for developing and implementing habitat management plans.
Mixed landownership and associated differences in mandates and management goals increase the need for inter-agency coordination in developing management strategies for xeric and lower montane forests. Coordination should extend to federal and state agencies in Colorado and Utah for juniper due to the peripheral nature of much of this habitat in Wyoming.

Manage ponderosa pine forests to mimic natural disturbance regimes to promote a diverse, fire-adapted forest mosaic.
Manage forest stands to improve vigor, age and species diversity; reduce fuel loads and wildfire intensity; and reduce competition between species to avoid future stand conditions that would again lead to landscape-level beetle mortality. Fire is not a precise tool and should not be utilized in stands where there is a significant departure from natural fire regimes. Better results can be obtained in these areas from mechanical treatments that allow managers to determine residual stand complexity and density, species and age selection and retain valued stand components such as snags. In these locations fire is better used as a maintenance tool following other treatments.

Develop methods to advance timber management practices that benefit wildlife on private lands.
Ponderosa pine forests comprise a large proportion of forest products despite being a small portion of Wyoming's commercially productive forest lands. These lands also provide critical habitat for many wildlife species. The adoption of wildlife-sensitive timber management practices should be encouraged through:

- Promoting the development and implementation of stewardship plans with participation in cost share programs.
- Increase the amount and accessibility of information and education to private landowners on the best management practices including reaching out to absentee landowners, developing assessment tools for landowners, training landowners on basic data collection techniques and basic forest management, and using local media to reach out to landowners.
- Encourage implementation of Forest Inventory and Analysis (FIA) in Wyoming

to capture information about private forest lands. (See above.)

- Provide financial incentives for management through the use of cost-share programs.
- Develop and implement certification programs for landowners including American Tree Farm System and Stewardship Forest Wyoming (Wyoming State Forestry Division 2010).

Work to mitigate the effects of land fragmentation.

- Encourage landowners to work together, rather than as individual entities, when developing subdivision-level habitat and timber management plans as part of subdivision development.
- Provide incentives to conserve working forest lands including conservation easements. The Forest Legacy Program can be a source of funding for these easements.
- Keep private forestry practices financially viable by developing and maintain a forest products industry infrastructure to provide consistent markets for forest products (Wyoming State Forestry Division 2010).

Habitat management and treatments should be followed by long-term monitoring where appropriate.

Tree removal and thinning can result in unintended consequences such as increases in invasive species. If an increase in weeds or erosion will likely occur after a burn, using mechanical removal may be the best option. To minimize the establishment of invasive species following fires, sterilized soils from intensely burned areas, including brush pile locations, should be inoculated by adding soil from unburned patches, and native seed mixes should be planted. The creation of maps that include data on treatment sites should be a component of post-treatment monitoring protocols. Special attention should be directed toward mechanical removal for problems such as heavy equipment damage to other plants and unseen changes in soil water retention. On large-scale treatment areas there is also a need to monitor the results to the ecological system. Depending on the size of the treatment, funding availability, land manager goals, and regulations, monitoring may range from merely photo points to multiple established transects both within and adjacent to the treatments.

Work with State Forestry to identify forest health conditions of low-elevation (below 8,500 feet) limber pine woodlands within priority wildlife areas to facilitation statewide management strategies.

The BLM is in the process of issuing direction on the *Whitebark and Limber Pine Management Strategies for Wyoming BLM* that includes the silvicultural prescriptions for limber as well as whitebark pine (Bureau of Land Management 2010b).

Work with State Forestry to develop silvicultural prescriptions that can be used to maintain limber pine woodlands on the landscape within priority wildlife habitat areas.

Thin limber pine stands to appropriate stocking levels to improve individual tree and stand vigor and to reduce interspecies competition in order to provide some stand resistance to mountain pine beetle attacks. Where feasible, plant WPBR-resistant limber pine seedlings to increase stand resistance to the disease.

Consult wildlife habitat priority areas and best management practices to improve energy development planning and mitigation design.

Energy development mitigation plans should stress avoiding biologically sensitive areas within project sites and directing off-site mitigation funds to nearby high-value wildlife locations. SWAP SGCN priority areas identified in Figure 15 , WGFD Strategic Habitat Plan Crucial areas, and Wyoming Sage-grouse Core Areas can help guide these efforts. The implementation of mitigation measures and/or best management practices detailed within the Wyoming Game and Fish Commission's *Recommendations for*

Development of Oil and Gas Resources within Important Wildlife Habitats (Wyoming Game and Fish Department 2010) and *Recommendations for Wind Energy Development in Crucial and Important Wildlife Habitat* (Wyoming Game and Fish Department 2010) should be encouraged. Mitigation plans should consider the need to reduce fragmentation of important habitats by using practices such as acquiring conservation easements and implementing associated stewardship plans in areas of high biological value.

Xeric and Lower Montane Forests Monitoring Activities

Continue monitoring xeric and lower montane forests SGCN in order to detect population trends or changes in distribution that may reflect habitat problems. This information should be used to guide future monitoring and research.

Monitor the landscape distribution and habitat intactness of xeric and lower montane forests through remote sensing. Remote sensing is useful in tracking the size, distribution, and fragmentation level of this habitat in Wyoming. Information gathered would be helpful in determining the cumulative impacts of activities and events such as energy development, rural subdivision, wildfire, and presence of invasive species. Special attention should be given to monitoring the level and location of these activities in relation to SWAP SGCN priority areas with a high proportion of xeric and lower montane forests habitat type (Figure 15). This technique may require the further development of monitoring protocols and identification of sample sites.

Whenever possible, establish vegetation monitoring transects to determine the vegetation and community responses to habitat treatments. Transects should include photo points, with special notes on invasive plant species.

Monitor the establishment and spread of invasive plant species in cooperation with Weed and Pest Districts and other federal and state agencies.

In cooperation with research entities, monitor the effects of climate change including extended periods of drought or pluvial cycles. Special attention should be given to the effects of climate on outbreaks of insects and disease.

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